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STRENGTH VALUES FOR STRUCTURAL TIMBERS.

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STRENGTH VALUES FOR STRUCTURAL TIMBERS.

TESTS ON STRUCTURAL TIMBERS.

This circular brings together in condensed form the average strength values resulting from a large number of tests made by the Forest Service on the principal structural timbers of the United States.[1] These results are more completely discussed in other publications of the Service, a list of which is given at the end of this circular, while most of them have also been furnished to the American Railway Engineering & Maintenance of Way Association and to various committees charged with the revision of the building laws of different cities. Their publication in the present form makes them available for quick reference by engineers, architects, builders, and other users of structural timbers.

The tests were made at the laboratories of the Forest Service, in cooperation with the following universities: Purdue University, Yale Forest School, University of California, University of Oregon, University of Washington, University of Colorado, and University of Wisconsin.

The Yellow Pine Manufacturers' Association, the E. P. Burton Lumber Co., the Redwood Manufacturers' Association, Oregon & Washington Lumber Manufacturers' Association, and the Pacific Coast Lumber Manufacturers' Association furnished, without cost, much of the material upon which the tests were made. Tests upon treated timbers, poles, crossarms, round mine timbers, and other structural forms are now being carried on.

RESULTS.

Tables 1 and 2 give the average results obtained from tests on green material, while Tables 3 and 4 give average results from tests on air-seasoned material. The small specimens, which were invariably 2 by 2 inches in cross section, were free from defects such as knots, checks, and cross grain; all other specimens were representative of material secured in the open market. The relation of stresses developed in different structural forms to those developed in the small clear specimens is shown for each factor in the column headed "Ratio to 2″ x 2″." Tests to determine the mechanical properties of different species are often confined to small clear specimens. The ratios included in the tables may be applied to such results in order to approximate the strength of the species in structural sizes, and containing the defects usually encountered, when tests on such forms are not available.

[1] The methods employed by the Forest Service in making mechanical tests on timber are described in Forest Service Circular 38, Revised, "Instructions to Engineers of Timber Tests," and in Bulletin 88 "Properties and Uses of Douglas Fir."

A comparison of the results of tests on seasoned material with those from tests on green material shows that, without exception, the strength of the 2 by 2 inch specimens is increased by lowering the moisture content, but that increase in strength of other sizes is much more erratic. Some specimens, in fact, show an apparent loss in strength due to seasoning. If structural timbers are seasoned slowly, in order to avoid excessive checking, there should be an increase in their strength. In the light of these facts it is not safe to base working stresses on results secured from any but green material. For a discussion of factors of safety and safe-working stresses for structural timbers, the reader is referred to the report of the committee on wooden bridges and trestles of the Railway Engineering & Maintenance of Way Association published in the Association Bulletin 107.

TABLE 1.—*Bending tests on green material.*

Species.	Sizes.		Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L.		M. of R.		M. of E.		Calculated shear.	
	Cross section.	Span.				Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Longleaf pine.....	12 by 12	138	4	28.6	9.7	4,099	0.83	6,710	0.74	1,523	0.99	261	0.86
	10 by 16	168	4	26.8	16.7	4,193	.85	6,453	.71	1,626	1.05	306	1.01
	8 by 16	156	7	28.4	14.6	3,147	.64	5,439	.60	1,368	.89	390	1.29
	6 by 16	132	1	40.3	21.8	4,120	.83	6,460	.71	1,190	.77	378	1.25
	6 by 10	180	1	31.0	6.2	3,580	.72	6,500	.72	1,412	.92	175	.58
	6 by 8	180	2	27.0	8.2	3,735	.75	5,745	.63	1,282	.83	121	.40
	2 by 2	30	15	33.9	14.1	4,950	1.00	9,070	1.00	1,540	1.00	303	1.00
Douglas fir.....	8 by 16	180	191	31.5	11.0	3,968	.76	5,983	.72	1,517	.95	269	.81
	5 by 8	180	84	30.1	10.8	3,693	.71	5,178	.63	1,533	.96	172	.52
	2 by 12	180	27	35.7	20.3	3,721	.71	5,276	.64	1,642	1.03	256	.77
	2 by 10	180	26	32.9	21.6	3,160	.60	4,699	.57	1,593	1.00	189	.57
	2 by 8	180	29	33.6	17.6	3,593	.69	5,352	.65	1,607	1.01	171	.51
	2 by 2	24	568	30.4	11.6	5,227	1.00	8,280	1.00	1,597	1.00	333	1.00
Douglas fir (fire-killed).....	8 by 16	180	30	36.8	10.9	3,503	.80	4,994	.64	1,531	.94	330	1.19
	2 by 12	180	32	34.2	17.7	3,489	.80	5,085	.66	1,624	.99	247	.89
	2 by 10	180	32	38.9	18.1	3,851	.88	5,359	.69	1,716	1.05	216	.78
	2 by 8	180	31	37.0	15.7	3,403	.78	5,305	.68	1,676	1.02	169	.61
	2 by 2	30	290	33.2	17.2	4,360	1.00	7,752	1.00	1,636	1.00	277	1.00
Shortleaf pine....	8 by 16	180	12	39.5	12.1	3,185	.73	5,407	.70	1,438	1.03	362	1.40
	8 by 14	180	12	45.8	12.7	3,234	.74	5,781	.75	1,494	1.07	338	1.31
	8 by 12	180	24	52.2	11.8	3,265	.75	5,503	.71	1,480	1.06	277	1.07
	5 by 8	180	24	47.8	11.5	3,519	.81	5,732	.74	1,485	1.06	185	.72
	2 by 2	30	254	51.7	13.6	4,350	1.00	7,710	1.00	1,395	1.00	258	1.00
Western larch....	8 by 16	180	32	51.0	25.3	3,276	.77	4,632	.64	1,272	.97	298	1.11
	8 by 12	180	30	50.3	23.2	3,376	.79	5,286	.73	1,331	1.02	254	.94
	5 by 8	180	14	56.0	25.6	3,528	.83	5,331	.74	1,432	1.09	169	.63
	2 by 2	28	189	46.2	26.2	4,274	1.00	7,251	1.00	1,310	1.00	269	1.00
Loblolly pine.....	8 by 16	180	17	45.8	6.1	3,094	.75	5,394	.69	1,406	.98	383	1.44
	5 by 12	180	94	60.9	5.9	3,030	.74	5,028	.64	1,383	.96	221	.83
	2 by 2	30	44	70.9	5.4	4,100	1.00	7,870	1.00	1,440	1.00	265	1.00
Tamarack.....	6 by 12	162	15	57.6	16.6	2,914	.75	4,500	.66	1,202	1.05	255	1.11
	4 by 10	162	15	43.5	11.4	2,712	.70	4,611	.68	1,238	1.08	209	.91
	2 by 2	30	82	38.8	14.0	3,875	1.00	6,820	1.00	1,141	1.00	229	1.00
Western hemlock.	8 by 16	180	39	42.5	15.6	3,516	.80	5,296	.73	1,445	1.01	261	.92
	2 by 2	28	52	51.8	12.1	4,406	1.00	7,294	1.00	1,428	1.00	284	1.00
Redwood.....	8 by 16	180	14	86.5	19.9	3,734	.79	4,492	.64	1,016	.96	300	1.21
	6 by 12	180	14	87.3	17.8	3,787	.80	4,451	.64	1,068	1.00	224	.90
	7 by 9	180	14	79.8	16.7	4,412	.93	5,279	.76	1,324	1.25	199	.80
	3 by 14	180	13	86.1	23.7	3,506	.74	4,364	.62	947	.89	255	1.03
	2 by 12	180	12	70.9	18.6	3,100	.65	3,753	.54	1,052	.99	187	.75
	2 by 10	180	13	55.8	20.0	3,285	.69	4,079	.58	1,107	1.04	169	.68
	2 by 8	180	13	63.8	21.5	2,989	.63	4,063	.58	1,141	1.08	134	.54
	2 by 2	28	157	75.5	19.1	4,750	1.00	6,980	1.00	1,061	1.00	248	1.00

TABLE 1.—*Bending tests on green material*—Continued.

Species.	Sizes.		Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L.		M. of R.		M. of E.		Calculated shear.	
	Cross section.	Span.				Average per square inch.	Ratio to 2″ by 2″.	Average per square inch.	Ratio to 2″ by 2″.	Average per square inch.	Ratio to 2″ by 2″.	Average per square inch.	Ratio to 2″ by 2″.
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Norway pine.....	6 by 12	162	15	50.3	12.5	2,305	0.82	3,572	0.69	987	1.03	201	1.17
	4 by 12	162	18	47.9	14.7	2,648	.94	4,107	.79	1,255	1.31	238	1.38
	4 by 10	162	16	45.7	13.3	2,674	.95	4,205	.81	1,306	1.36	198	1.15
	2 by 2	30	133	32.3	11.4	2,808	1.00	5,173	1.00	960	1.00	172	1.00
Red spruce.....	2 by 10	144	14	32.5	21.9	2,394	.66	3,566	.60	1,180	1.02	181	.80
	2 by 2	26	60	37.3	21.3	3,627	1.00	5,900	1.00	1,157	1.00	227	1.00
White spruce.....	2 by 10	144	16	40.7	9.3	2,239	.72	3,288	.63	1,081	1.08	166	.83
	2 by 2	26	83	58.3	10.2	3,090	1.00	5,185	1.00	998	1.00	199	1.00

TABLE 2.—*Compression and shear tests on green material.*

Species.	Compression ∥ to grain.						Compression ⊥ to grain.					Shear.		
	Size of specimen.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	M. of E., per square inch.	Cr. str. at max. ld., per square inch.	Stress area.	Height.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	Number of tests.	Per cent of moisture.	Shear strength.
	Inches.			*Lbs.*	*1,000 lbs.*	*Lbs.*	*Inches.*	*In.*			*Lbs.*			*Lbs.*
Longleaf pine..	4 by 4	46	26.3	3,480	.....	4,800	4 by 4	4	22	25.3	568	44	21.8	973
	2 by 2	14	34.7	.....	.....	4,400	.....	.....	.....	.....	.....	.....	.....	.....
Douglas fir.....	6 by 6	515	30.7	2,780	1,181	3,500	4 by 8	16	259	30.3	570	531	29.7	765
	5 by 6	170	30.9	2,720	2,123	3,490	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	902	29.8	3,500	1,925	4,030	.....	.....	.....	.....	.....	.....	.....	.....
Douglas fir (fire-killed).....	6 by 6	108	34.8	2,620	1,801	3,290	6 by 8	16	24	33.7	368	77	35.8	631
	2 by 2	204	37.9	.....	.....	3,430	.....	.....	.....	.....	.....	.....	.....	.....
Shortleaf pine..	6 by 6	95	41.2	2,514	1,565	3,436	5 by 8	16	12	37.7	361	179	47.0	704
	5 by 8	23	43.5	2,241	1,529	3,423	5 by 8	14	12	42.8	366	.....	.....	.....
	2 by 2	281	51.4	.....	.....	3,570	5 by 8	12	24	53.0	325	.....	.....	.....
	.....	.....	.....	.....	.....	.....	5 by 5	8	24	47.0	344	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	277	48.5	400	.....	.....	.....
Western larch..	6 by 6	107	49.1	2,675	1,575	3,510	6 by 8	16	22	43.6	417	179	40.7	700
	2 by 2	491	50.6	3,026	1,545	3,696	6 by 8	12	20	40.2	416	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 6	6	53	52.8	478	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	30	50.4	472	.....	.....	.....
Loblolly pine..	8 by 8	14	63.4	1,560	365	2,140	8 by 4	8	16	67.2	392	121	83.2	630
	4 by 8	18	60.0	2,430	691	3,560	4 by 4	8	38	44.6	546	.....	.....	.....
	2 by 2	53	74.0	.....	.....	3,240	.....	.....	.....	.....	.....	.....	.....	.....
Tamarack.....	6 by 7	4	49.9	2,332	1,432	3,032	.....	.....	.....	.....	.....	24	39.2	668
	4 by 7	6	27.7	2,444	1,334	3,360	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	165	36.8	.....	.....	3,190	.....	.....	.....	.....	.....	.....	.....	.....
Western hemlock.....	6 by 6	82	46.6	2,905	1,617	3,355	6 by 4	6	30	48.7	434	54	65.7	630
	2 by 2	131	55.6	2,938	1,737	3,392	.....	.....	.....	.....	.....	.....	.....	.....
Redwood.....	6 by 6	34	83.6	3,194	1,240	3,882	6 by 8	16	13	86.7	473	148	84.2	742
	2 by 2	143	72.1	3,490	1,222	3,980	6 by 6	12	14	83.0	424	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 7	9	13	74.7	477	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 3	14	13	75.6	411	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	12	12	66.5	430	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	10	11	55.0	423	.....	.....	.....
	.....	.....	.....	.....	.....	.....	6 by 2	8	12	56.7	396	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	186	75.5	569	.....	.....	.....
Norway pine...	6 by 7	5	29.0	1,928	905	2,404	.....	.....	.....	.....	.....	20	26.7	589
	4 by 7	8	28.4	2,154	1,063	2,652	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	178	26.8	.....	.....	2,504	.....	.....	.....	.....	.....	.....	.....	.....
Red spruce.....	2 by 2	58	35.4	.....	.....	2,750	2 by 2	2	43	31.8	310	30	32.0	758
White spruce...	2 by 2	84	61.0	.....	.....	2,370	2 by 2	2	46	50.4	270	40	58.0	651

TABLE 3.—*Bending tests on air-seasoned material.*

Species.	Sizes.		Number of tests.	Per cent of moisture.	Rings per inch.	F. S. at E. L.		M. of R.		M. of E.		Calculated shear.	
	Cross section.	Span.				Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".	Average per square inch.	Ratio to 2" by 2".
	Inches.	*Ins.*				*Lbs.*		*Lbs.*		*1,000 lbs.*		*Lbs.*	
Longleaf pine	8 by 16	180	5	22.2	16.0	3,390	0.50	4,274	0.37	1,747	1.00	288	0.75
	6 by 16	132	1	23.4	17.1	3,470	.51	6,610	.57	1,501	.86	388	1.01
	6 by 10	177	2	19.0	8.8	4,560	.68	7,880	.68	1,722	.99	214	.56
	4 by 11	180	1	18.4	23.9	3,078	.46	8,000	.69	1,660	.95	251	.66
	6 by 8	177	6	20.0	13.7	4,227	.63	8,196	.71	1,634	.94	177	.46
	2 by 2	30	17	15.9	13.9	6,750	1.00	11,520	1.00	1,740	1.00	383	1.00
Douglas fir	8 by 16	180	91	20.8	13.1	4,563	.68	6,372	.61	1,549	.91	269	.64
	5 by 8	180	30	14.9	12.2	5,065	.76	6,777	.65	1,853	1.09	218	.52
	2 by 2	24	211	19.0	16.4	6,686	1.00	10,378	1.00	1,695	1.00	419	1.00
Shortleaf pine	8 by 16	180	3	17.0	12.3	4,220	.54	6,030	.50	1,517	.85	398	.98
	8 by 14	180	3	16.0	12.3	4,253	.55	5,347	.44	1,757	.98	307	.76
	8 by 12	180	7	16.0	12.4	5,051	.65	7,331	.60	1,803	1.01	361	.89
	5 by 8	180	6	12.2	22.5	7,123	.92	9,373	.77	1,985	1.11	301	.74
	2 by 2	30	67	14.2	13.7	7,780	1.00	12,120	1.00	1,792	1.00	404	1.00
Western larch	8 by 16	180	23	18.3	21.9	3,343	.57	5,440	.53	1,409	.90	349	.96
	8 by 12	180	29	17.8	23.4	3,631	.62	6,186	.60	1,549	.99	295	.81
	5 by 8	180	10	13.6	27.6	4,730	.80	7,258	.71	1,620	1.04	221	.61
	2 by 2	30	240	16.1	26.8	5,880	1.00	10,254	1.00	1,564	1.00	364	1.00
Loblolly pine	8 by 16	180	14	20.5	7.4	4,195	.81	6,734	.72	1,619	1.10	462	1.45
	6 by 16	126	4	20.2	5.0	2,432	.47	4,295	.46	1,324	.90	266	.84
	6 by 10	174	3	21.3	4.7	3,100	.60	6,167	.66	1,449	.99	173	.54
	4 by 12	174	4	19.8	4.7	2,713	.52	5,745	.61	1,249	.85	185	.58
	8 by 8	180	9	22.9	4.9	2,903	.56	4,557	.48	1,136	.77	93	.29
	6 by 7	144	2	21.1	5.0	2,990	.58	4,968	.53	1,286	.88	116	.36
	4 by 8	132	8	19.5	9.1	3,384	.65	6,194	.66	1,200	.82	196	.62
	2 by 2	30	123	17.6	6.6	5,170	1.00	9,400	1.00	1,467	1.00	318	1.00
Tamarack	6 by 12	162	5	23.0	15.1	3,434	.45	5,640	.43	1,330	.82	318	.75
	4 by 10	162	4	14.4	9.7	4,100	.54	5,320	.41	1,356	.84	252	.59
	2 by 2	30	47	11.3	16.2	7,630	1.00	13,080	1.00	1,620	1.00	425	1.00
Western hemlock	8 by 16	180	44	17.7	17.8	4,398	.69	6,420	.62	1,737	1.04	406	1.06
	2 by 2	28	311	17.9	19.4	6,333	1.00	10,369	1.00	1,666	1.00	382	1.00
Redwood	8 by 16	180	6	26.3	22.4	3,797	.79	4,428	.57	1,107	.96	294	1.05
	6 by 12	180	6	16.1	17.7	3,175	.66	3,353	.43	728	.64	167	.60
	7 by 9	180	6	15.9	15.2	3,280	.69	4,002	.51	1,104	.96	147	.53
	3 by 14	180	6	13.1	24.4	.....	.....	5,033	.64	.....	.....	291	1.04
	2 by 12	180	5	13.8	14.4	3,928	.82	5,336	.68	1,249	1.09	260	.93
	2 by 10	180	5	13.8	24.8	3,757	.79	4,606	.59	1,198	1.05	186	.67
	2 by 8	180	6	13.7	20.7	4,314	.90	5,050	.65	1,313	1.15	166	.60
	2 by 2	28	122	15.2	18.8	4,777	1.00	7,798	1.00	1,146	1.00	279	1.00
Norway pine	6 by 12	162	5	16.7	8.1	2,968	.56	5,204	.61	1,123	.97	286	1.02
	4 by 10	162	5	13.7	12.0	5,170	.98	6,904	.82	1,712	1.48	317	1.13
	2 by 2	30	60	14.9	11.2	5,280	1.00	8,470	1.00	1,158	1.00	281	1.00

TABLE 4.—*Compression and shear tests on air-seasoned material.*

Species.	Compression ∥ to grain.						Compression ⊥ to grain.					Shear.		
	Size of specimen.	Number of tests.	Per cent of moisture.	Cr. str. at E. L., per square inch.	M. of E., per square inch.	Cr. str. at max. ld., per square inch.	Stress area.	Height.	Number of tests.	Per cent. of moisture.	Cr. str. at E. L., per square inch.	Number of tests.	Per cent of moisture.	Shear strength per square inch.
	Inches.			*Lbs.*	*1,000 lbs.*	*Lbs.*	*Inches.*	*In.*			*Lbs.*			*Lbs.*
Long-leaf pine..	4 by 5	46	26.3	3,480	.....	4,800	4 by 5	4	22	25.1	572	52	20.2	984
Douglas fir.....	6 by 6	259	20.3	3,271	1,038	4,258	4 by 8	16	44	20.8	732	465	22.1	822
	2 by 2	247	18.7	3,842	1,084	5,002	4 by 8	10	32	18.1	584	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	8	51	20.2	638	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	6	49	24.0	613	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	29	24.8	603	.....	.....	.....
Short-leaf pine.	6 by 6	29	15.7	4,070	1,951	6,030	8 by 5	16	4	17.8	725	85	.....	1,135
	2 by 2	57	14.2	.....	.....	6,380	8 by 5	14	3	16.3	757	.....	.....	.....
	.....	.....	.....	.....	.....	.....	8 by 5	12	5	15.1	730	.....	.....	.....
	.....	.....	.....	.....	.....	.....	5 by 5	8	6	13.0	918	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	57	13.9	926	.....	.....	.....
Western larch..	6 by 6	112	16.0	.....	.....	5,445	8 by 6	16	17	18.8	491	193	15.0	905
	4 by 4	81	14.7	.....	.....	6,161	8 by 6	12	18	17.6	526	.....	.....	.....
	2 by 2	270	14.8	.....	.....	5,934	5 by 4	8	22	13.3	735	.....	.....	.....
Loblolly pine ..	6 by 6	23	.....	3,357	1,693	5,005	8 by 5	16	12	19.8	602	156	11.3	1,115
	5 by 5	10	22.4	2,217	545	2,950	8 by 5	8	7	22.9	679	.....	.....	.....
	4 by 8	8	19.4	3,010	633	3,920	4 by 5	8	8	19.5	715	.....	.....	.....
	2 by 2	69	.....	.....	.....	5,547	.....	.....	.....	.....	.....	.....	.....	.....
Tamarack.....	6 by 7	3	15.7	2,257	1,042	3,323	2 by 2	2	57	16.2	697	60	14.0	879
	4 by 7	3	13.6	3,780	1,301	4,823	.....	.....	.....	.....	.....	.....	.....	.....
	4 by 4	57	14.9	3,386	1,353	4,346	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	66	14.6	.....	.....	4,790	.....	.....	.....	.....	.....	.....	.....	.....
West hemlock..	6 by 6	102	18.6	4,840	2,140	5,814	7 by 6	15	25	18.2	514	131	17.7	924
	2 by 2	463	17.0	4,560	1,923	5,403	6 by 6	6	26	16.8	431	.....	.....	.....
	.....	.....	.....	.....	.....	.....	4 by 4	4	6	15.9	488	.....	.....	.....
Redwood.....	6 by 6	18	16.9	.....	.....	4,276	8 by 6	16	5	25.4	548	95	12.4	671
	2 by 2	115	14.6	.....	.....	5,119	6 by 6	12	6	14.7	610	.....	.....	.....
	.....	.....	.....	.....	.....	.....	7 by 6	9	5	14.8	500	.....	.....	.....
	.....	.....	.....	.....	.....	.....	3 by 6	14	2	12.6	470	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	12	2	16.2	498	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	10	4	14.3	511	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 6	8	2	13.2	429	.....	.....	.....
	.....	.....	.....	.....	.....	.....	2 by 2	2	145	13.8	564	.....	.....	.....
Norway pine...	6 by 7	4	15.2	2,670	1,182	4,212	2 by 2	2	36	10.0	924	44	11.9	1,145
	4 by 7	2	22.2	3,275	1,724	4,575	.....	.....	.....	.....	.....	.....	.....	.....
	4 by 4	55	16.6	3,048	1,367	4,217	.....	.....	.....	.....	.....	.....	.....	.....
	2 by 2	44	11.2	.....	.....	7,550	.....	.....	.....	.....	.....	.....	.....	.....

NOTE.—Following is an explanation of the abbreviations used in the foregoing tables:
F. S. at E. L.=Fiber stress at elastic limit.
M. of E.=Modulus of elasticity.
M. of R.=Modulus of rupture.
Cr. str. at E. L.=Crushing strength at elastic limit.
Cr. str. at max. ld.=Crushing strength at maximum load.

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[1] Not available for free distribution, but can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C.

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